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NOTES ON THE QUATERNARY GEOLOGY OF THE MATTAWA AND OTTAWA VALLEYS.

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F. B. TAYLOR, Fort Wayne, Ind.

[*From The American Geologist, Vol. XVIII, August, 1896.*]

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Introductory. In the autumn of 1893 the writer made two excursions to North Bay on lake Nipissing, first in August with Dr. F. S. Pearce, of Philadelphia, and again in September alone. Two or three days were spent each time searching for old shore lines on the hills or in studying the lower beaches and their relation to the old outlet of the great lakes. The greater part of the time, however, was spent in searching for high beaches, and particularly in an effort to identify the highest. The observations made then were afterwards published in detail.*

In 1895 the month of October was spent chiefly in the vicinity of North Bay and in the Ottawa valley above the city of Ottawa. It is the particular object of the present paper to present the results of this later work. The observations are somewhat scattered, but when taken in connection with what has been done by others and with the writer's work of two years before it is believed that they will not be without value. The paper is presented in two parts, the first relating to the higher, older shore lines, and the second relating to the lower, newer lines, in part lacustrine and associated with the abandoned outlet and in part to those of the contemporary marine waters in the Ottawa valley.

I. SHORE LINES AT HIGH LEVELS.

North Bay. The Nelson and McEwen beaches on the hills five miles northeast of North Bay were described in the pre-

*Bull. Geol. Soc. Am., vol. 5, 1893. Contains map of old outlet and of higher beaches north of North Bay. Also AM. GEOL., vol. XIV, Nov., 1894, pp. 282-285, with map.

vious paper.* They are both strongly and clearly developed. Another, called the Thibeault beach, on the hill about two and half miles north of North Bay was also described. The part seen there was only a short fragment and on revisiting the place last season it was found to be a weak feature and not well developed. The lands along the slope to the westward are better cleared now and although they present a rather irregular surface of drift and are in a very exposed place the beach was barely distinguishable upon them. From this I am rather inclined to doubt the propriety of classing this beach as one of the greater beaches to be used in correlations with other more strongly developed parts elsewhere. It is too weak and poorly defined to be safely used for that purpose.

Going north from Thibeault's the road is mostly through the forest and no conspicuous evidence of submergence was noticed. Half a mile north of Thibeault's a short ridge in the woods resembles a spit at about 1,050 feet; but its origin is not certain. About four and a half miles from town Chippewa creek was crossed at about 990 feet. The high fresh cut bank showed sand mixed with white silt, but showed scarcely any evidences of stratification. Above this is a stretch of slightly rolling ground with sandy soil at about 1,100 feet. This substantially corresponds with the level of the McEwen beach at about 1,095 feet (corrected).† This tract gradually rises to an ill-defined low bluff at about 1,130 feet and is probably the Nelson beach. From this rise a level plain extends about a mile through a maple forest to the house of Mr. McKenzie on the west side of the road six miles from North Bay. The altitude at McKenzie's and for nearly a mile south is about

*See first paper mentioned in preceding footnote. The name "Nelson beach" was never intended to have the wide application given it in recent papers by Mr. Warren Upham, but was used merely as a locality-name for convenience. Being a well determined part of the "highest beach" in a situation where it cannot be attributed to small or locally restricted waters, it is plain that the Nelson beach is in reality merely a part of the Algonquin beach.

†In the previous papers the altitude of the station at North Bay was supposed to be 658 feet above mean tide. The C. P. R. profile, obtained afterwards through the courtesy of the Geological Survey of Canada, makes it 662 feet. This correction, by adding four feet, should be made for all the points in the earlier paper that were measured from North Bay station.

1,150 feet. East of the road is Chippewa lake and other little ponds five or ten feet lower. North of the lake is a network of narrow, crooked, steep-sided, stony ridges with marshy hollows enclosed, probably glacial forms. Mr. McCollen's house is on a partially cleared hill to the east which rises to over 1,200 feet. The soil is a stony till with some sand and plenty of bowlders. No evidence of wave-wash or still-water sedimentation was seen above about 1,130 feet. A mile farther north near the cabins of two Frenchmen west of the road an old bluff was found at about the same hight facing over a swamp which borders Duchesnay creek—probably another fragment of the Nelson or Algonquin beach.

Trout Creek. Two efforts were made in 1893 to reach the highest beach at Trout creek, about 28 miles south-southeast of North Bay. Both failed on account of rain. This season another attempt was made with better success. A thin snow covered the ground in the morning, but by noon had disappeared. On the face of a steep hill about a mile east of the station the Algonquin beach was found in a cleared field facing northwest over the valley. It appears here in the form of a series of lightly cut terraces or steps. Beginning in the woods below the field eight benches were distinguished at altitudes of about 1,150, 1,165, 1,170, 1,175, 1,185, 1,195, 1,205 and 1,215 feet above sea level. Some of them are low ridges with shallow depressions behind. Those at 1,175, 1,185 and 1,195 are best developed, the last one the best of the three. The upper one has a low bluff of bowldery clay three to four feet high at its back in the northern part of the field, but fades away on the slope to the south. This bluff rises gently to a low knob at the north and passes into the woods. Near the north side of the field where it is most distinct the waves made a deeper cut, producing a slight indentation of the bluff line, like a small amphitheater. The tough clay of the slope is thickly massed with bowlders. The front of the low bluff shows plainly that the clay has been washed out, leaving the stones bare. The terrace is 50 to 60 feet wide. The road south of the field crosses a small stream and a small deltoid flat about 15 feet lower than the upper bench. These terraces were followed through the woods toward the southwest where some of them are more strongly developed, and

the upper one was traced a short distance south of the road. The surface of the field above the upper bench shows no benches, but only a number of rain gulleys. From the top of the field, (at about 1,335 feet) the view over the valley showed that several hill tops two or three miles away formed a considerable protection againt the open sweep of waves from over lake Nipissing. A level terrace line could be seen between two of these hills apparently at the same level as the benches just described. Half a mile farther east the road ends on a hill top. From this point one looks down on a hilly landscape of forest and field, the latter strewn with many large bowlders. In the road on the hill top there is one 15 feet long, 12 feet wide and projecting 10 feet above the ground. The altitude is here about 1,405 feet. No sign of submergence was seen above the terraces described.

Two miles north of Trout creek on the Pawassan road this beach was found again at about 1,220 feet. The position here is more exposed and the beach is correspondingly stronger in its development. It is a great curved spit of gravel about 400 or 500 feet long. It is mostly on Mr. Weiler's land in the [illegible] which fills the corner southeast of the cross roads. I[illegible] next lot east a gravelly hill of drift rises about 25 feet [illegible] the top of the spit. From the top of this hill lake Nip[illegible] can be seen plainly. The waves had torn away the north [illegible] of this hill, making a sharp cut at the water line and leaving a very steep slope above. From this the gravel and sand were carried toward the southwest into shallow water and built into a wide spit which curves slightly southward. The soil on the spit is remarkably light. It is composed of fine gravel and sand, with a light loess-like material, and is very soft under foot. The hill was evidently a small island at the time of the beach. A mile to the east in a more protected place the knobs of gneiss had apparently been washed bare of their thin coating of drift at about the same level. All the hill tops for several miles around were islands. Some of these extended two or three miles farther northward.

Callender (*C. P. R.*). From this place a drive was made out the Pawassan road to a hill some six miles south-southeast. For two or three miles, and up to about 250 feet above the station, the country surface is largely silt and silty clay

with more or less sand, all water-laid thinly over the rocks and the ground moraine. On the west point of a hill about two miles out is a faint terrace about 190 feet above the station or about 975 above sea level. Just northeast of this is a large kettle-hole 60 to 70 feet deep. The rolling stony drift at this place appeared to be part of a terminal moraine. Some of the hills seem to be mainly of drift, but some show bare ledges of gneiss, especially towards their tops. A wide huckleberry flat called the "Blue Sea," which was crossed at about 1,035 feet, is bounded by high hills and is evidently a shallow lake bed filled with sediments. From the east side of this a long hill rises quite steeply. Bare bosses of gneiss were reached at the top of the slope at about 1,290 feet. They were evidently rounded by glacial action, but were weathered so that no striæ were discoverable. The house and barn of Mr. Joseph Binet, half way up the hill and north of the road, are on a fairly well formed terrace at about 1,135 feet above sea level. Above this are two others at about 1,150 and 1,170 feet respectively, both more sharply cut. Above the upper one is a steep rocky ledge with talus top about 30 feet above. The water may have stood at that place, but no distinct terrace corresponding to it was observed at that level on the gentler slope a few rods to the southwest. The benches are cut into stony drift, which is composed of tough clay with many cobbles. The slope faces nearly northwest and on the steep hills opposite there appeared to be a zone of rock washed bare at about the same level. Although it is about 40 feet lower than the beach at Trout creek, it seems almost certain that this is the Algonquin beach. The ground and situation are favorable, but no trace of submergence was seen at a higher level.

Localities in the Ottawa Valley. Two trips were made in search of high shore lines from Mattawa. The first was up the west side of the Ottawa river to Les Erables. At one place north of the Antoine river a faint terrace with gravelly surface suggesting light wave wash was found at about 870 feet. Birch hill farther north holds a small lake high above the river. The north slope of the hill is a great mass of morainic material undoubtedly constituting a terminal. It is apparently this bank of drift which holds the small lake up. The composition of the moraine is well shown in exposures by

the road which descends northward through a steep ravine. It is stony, gravelly drift with considerable sand and much white silt. A quarter of a mile south of this lake the slope on the west was explored and a horizontal zone of bowlders apparently washed free of other materials was found at about 1,010 feet. From the top of the hill 50 feet higher the surrounding hills were seen to have a similar mark on their steeper slopes. No other littoral forms were seen and it is uncertain whether this feature is in reality a shore line.

The second trip was made from Mattawa to Hurdman's farm about 21 miles south. About three miles out and at an altitude of about 720 feet a ridge of gravel and cobbles was found running north and south and exposed over lower ground both east and west. The southern part is level, but it drops off slightly towards its north end. This was not certainly identified as a beach, but may prove to be such on closer examination. At this level there is an undulating plain two or three miles wide and much of it is covered with a thin sheet of white silt with some clay. It is water-laid, and in some sections four to five feet deep was seen to be free of stones. It appeared generally to overlie stony drift, which outcrops at many places. In the drift itself the silt seemed to be the main fine ingredient mixed with the stones. It takes the place of clay largely in making up the ground moraine. The same character was frequently seen in other places in this region. As observed on this excursion, the upper limit of the water-laid silt appeared to be at about 800 feet. From Roscoe's, six miles out, the road to Hurdman's is over a very rough, rocky country, for the greater part consisting of bosses of gneiss with half buried ravines between. The drift covering is generally rather thin, and almost the whole stretch is thickly covered with bowlders. The average is a good size, a foot or more in diameter with many much larger, mostly angular and nearly all of varieties of gneiss or granite. Two terraces of fine sandy gravel were found at about 1,060 and 1,160 feet. Both were in a somewhat protected position in an east-west valley and covered with dense undergrowth. It is doubtful whether either is a beach. Nothing else suggesting submergence or a shore line was seen. Hurdman's house is about 1,320 feet above sea level while some of the knobs in the fields

near by rise to 1,400 feet or over. This is the top of the country and affords a grand view all around. One looks away east and south over the tops of many hills that rise almost to the same level, forming apparently an ancient peneplain. Between the hills are deep valleys often wide, holding many lakes and streams that flow eastward with moderate descent. Towards the northeast the hills of Quebec north of the Ottawa river were seen clearly.

At Deux Rivieres, 22 miles east of Mattawa, another effort was made to find high shore lines. Almost the whole distance of eight miles south to Stony hill was over what are locally called "the plains" but which proved to be a great area of kames. This kame deposit is composed almost entirely of yellow sand too coarse to be blown by the wind. Deux Rivieres has an altitude of 520 feet above sea level (C. P. R. profile) and the limit of the sands was not reached on Stony hill at an altitude of about 1,210 feet. Upon this slope of over 700 feet in something less than eight miles the deposit is spread in characteristic kame fashion. In some parts the knob and-basin topography is well developed. Other parts are billowy and others more nearly a plain. There are also some high, rather irregular ridges. Some of the kettles are 50 to 75 feet deep. All that were seen were dry, but there are a few lakes in the larger basins. About six miles out the road passes in view of Green lake along its west side. This lake is perhaps half a mile long and nearly as wide and is approximately 450 feet above the station (970 feet above sea level). In the central and lower part of the area the stony ground moraine seldom protrudes through the sand. But towards the south in the higher part of the area stony drift surfaces are common. The sand appeared to thin out in that direction and occurs there in patches. At an altitude of about 1,130 feet a distinct terrace about 300 to 400 feet wide was found facing north or slightly west of north. This shelf sloped from back to front ten or twelve feet and had a few bowlders scattered over its surface. The bluff at its back is high but not steep. The bench was followed to the east, where it fades away on a steeper slope, but no certain evidence of wave work was found—nothing resembling a beach ridge nor a spit nor did the bluff seem quite like one cut by wave action. It is not quite certain that

this terrace is a beach although it so strongly resembles one. Above its level there is the same billowy surface of sand and close to the road at about 1,210 feet there is a small steep-sided kettle about 15 feet deep. The sand as seen on this road appeared to be gathered more densely along three east-west belts, one low down, say 650 to 700 feet, another at 900 to 1,000 along the north side of Green lake and apparently holding it up, and a third at the top of the hill, 1,100 to 1,200 feet. The middle one shows bowldery knobs that seem to mark it as a terminal moraine. About two miles southeast of Green lake is Windigo lake, said to be larger and at about the same altitude, and Windigo hill as high or higher than Stony hill. Their basins are probably of impervious drift or rock underlying the sand.

The area of the sand is said to have very definite limits on the east and west extending about two miles each way from the road. Southward it thins out, but is said to extend several miles beyond Stony hill.

Nearly opposite Deux Rivieres the deep narrow valley of the Maganasippi river opens through the high plateau of Quebec, and it seems probable that the glacial drainage that formed the kame deposit was in some way related to that valley. The relation here is much like that described by Prof. Fairchild between the large kame areas of western New York and the deep valleys which indent the south shore of lake Ontario.*

Somewhat similar sand formations, but not so extensive nor, so far as seen, reaching to so high a level, were found at Bissett 12 miles and at Mackey 25 miles farther east. The knob-and-basin structure is not quite so prominent at either of these places, but at both there is a great rolling sand deposit overlying the ground moraine. At Bissett it was followed up to an altitude of about 800 feet above tide and at Mackey up to about 600 feet. At McKinnie's farm on the hill south of Mackey the highest point reached was nearly 800 feet, but above 600 feet the surface is of stony, gravelly clay. No trace of shore lines or sedimentation was seen on the upper slopes. At neither of these places, however, were

* "Kame Areas in Western New York south of Irondequoit and Sodus Bays," by H. L. Fairchild, Jour. of Geol. vol. IV, No. 2, 1896.

hights above 1,000 feet reached. Just opposite Mackey the valley of the river Du Moine opens towards the north just as does the Maganasippi at Deux Rivieres. At Bissett there is no valley opening exactly opposite. A small one opens from the north a few miles below, but at neither of these places did the relation of the sand area to the opposite valley seem so plain as at Deux Rivieres.

Eastward from Deux Rivieres the railway passes by a back valley and rises to 827 feet at Aylen. This valley appears to have been swept bare of nearly everything but bowlders. Much the same appearance was presented by the region east of Mackey past Moor and Bass lakes where the railway again rises to about 700 feet. It is not improbable that these valleys were swept out by the outrushing waters of lake Algonquin when the ice front still blocked the course of the Ottawa which lies a few miles farther north. Perhaps the sand deposits at Bissett and Mackey were modified by the same cause. Perhaps they might otherwise have been typical kame areas like that at Deux Rivieres.

The new observations near North Bay and those at Trout creek and Callender (C. P. R.) accord closely with what had been done before in that region. There can be no doubt of the recent presence of wide waters at high levels over lake Nipissing and the headwaters of the Mattawa river. At the five places seen in the Ottawa valley, however, no clear and certain evidence of high level submergence was found, except, perhaps, the thin silts and clays overlying the drift south of Mattawa up to about 800 feet. This limit for such a deposit would seem to imply a contemporary water surface at a still higher level, and it is more than probable that for a comparatively brief period such an eastward extension actually existed.

As related elsewhere, the results attained during the preceding month on the north coast of lake Superior, showing that there were no straits northward to Hudson bay, seemed to leave little support for the marine hypothesis of the highest beach in the northern part of the lake basins unless that hypothesis could be shown to be strongly reinforced by evidences from the region to the east of North Bay. The observations in the Ottawa valley are too meager to be taken as

final. But so far as they go they not only add nothing to the marine hypothesis, but the presence of the Deux Rivieres kame deposit, which appears to have been the latest noticeable phase of deposition at that place, suggests rather the hypothesis of a glacier dam. The absence of silt or clay overlying the sand on the lower part of the slope proves that the latter was not long submerged beneath still water after it was uncovered by the retreating ice. The Mattawa and Ottawa valleys are troughs in the ancient peneplain of the region and they are comparatively narrow and deep. It is impossible to deny that if a great sheet of land ice moved over this region from the north or north-northeast, as the striæ indicate, there may have been a short period when the ice blocked the Ottawa valley by filling it up for some distance east of Deux Rivieres and resting its front against the southern highlands below that place. The valleys to the west and possibly also for a short distance north above Mattawa may have been temporarily open water. But this condition would last only a short time at most. Perhaps this supposition explains the absence of stronger shore lines and the general absence of still-water sediments at high levels north and east of Mattawa, and it may be that the faint, doubtful shore lines and the thin silts south of Mattawa are in reality the remains of such short-lived still waters. The great valley of the river Du Moine reaching far to the north offers an appropriate channel, both as to position and direction with reference to ice-motion, for a great lobe or tongue of ice that may have formed a dam below Deux Rivieres. About two miles east of Mackey striæ were found running S. 20° and 25° W. (mag.). A little north of Mattawa on the west side of the river they bear nearly south (the direction here was not measured by compass). One and a half miles northwest of North Bay fine specimens of striæ were found close to the railway track and the predominant direction of the stronger ones is about S. 18° W., with a few running 5° to 10° east of south. No striæ were seen at the other places named. It is perhaps a significant fact that the scoured valleys east of Deux Rivieres and Mackey are just where the front of the Du Moine glacier would be at one stage of its retreat. These ideas, however, are not offered as conclusions which can be clearly affirmed

on the facts now at hand, but merely as suggestions which are indicated by these facts and which may be profitably borne in mind in future investigations.

One other point deserves mention in this connection. From Huntsville to South river the Algonquin beach rises at the rate of nearly six feet per mile.* Then from South river to Trout creek it appears to be about level. But from Trout creek to Nelson's, five miles northeast of North Bay, the beach descends northward about 75 feet in 33 miles. The Callender (C. P. R.) observation also shows the same northward descent. If the fainter forms found in the Ottawa valley are accepted as continuations of this same shore line, as they may be, then they too show northward descent and apparently a slight eastward descent also. It might be thought that the northward descent from Trout creek to Nelson's is not in reality a measure of the deformation of the Algonquin plane, but that the beaches at the two places are not the same. This is of course a possibility. But at each locality, at South river, Trout creek, Callender (C. P. R.) and near North Bay in 1893 and again in 1895, the greatest care was taken to determine the upper limit of submergence and the result was clear and satisfactory in each case. Callender (C. P. R.) is about 18 miles east of a straight line drawn from Trout creek to Nelson's. The northward component of distance from Trout creek to Callender is about 21 miles and from Callender to Nelson's about 12 miles. The altitudes of the beaches are, 1,220 feet at Trout creek, 1,170 at Callender and 1,145 at Nelson's. Thus the northward descent from Trout creek to Callender is nearly two and a half feet per mile while that from Callender to Nelson's is a little over two feet per mile. This allows nothing for a possible east-west deformation affecting Callender.

The beaches at these three localities are so situated that it can hardly be supposed that one was made and abandoned before another was begun. And the clear definition of each as the highest shore line adds much strength to the supposition of their unity as one beach.

*Am. Geol., vol. xiv, Nov., 1894.

Wherever the hills were ascended in the region east and northeast of Georgian bay it became at once apparent that their even tops were the remains of an ancient peneplain. From the hills south of Callender (C. P. R.) Mt. Talon, 15 or 20 miles to the north and beyond the Mattawa valley, was seen rising high above the general plain as a fine monadnock. No other so prominent was noticed in this region. In the highlands south of the Mattawa the Algonquin beach marks a water level that entered the deep valleys between the hills and extended far into the interior. On the north side of the Mattawa not only is the beach depressed, but the peneplain seems to show a corresponding depression also. In short, the descent of the Algonquin beach northward from Trout creek appears to be due to deformation since the beach was made, and it seems probable, therefore, as previously stated,* that there are post-Algonquin faults between Trout creek, or rather between South river, or Sundridge and Nelson's. And this deformation appears to have been finished before the beginning of the Nipissing beach.

The upheavals which tilted and warped the plane of the Algonquin beach before the formation of the Nipissing beach have been called the Algonquin uplifts.† Whether these occurred after, or part of them during the making of the Algonquin beach is a very complex question, which is full of importance in its bearing on the lake history and the history of the Niagara gorge. There is much reason to believe that the Simcoe region, including the Trent valley outlet, was raised during the life of lake Algonquin and before the breaking of the ice dam in the Ottawa valley. Sharp warping occurs in the region east and northeast of Georgian bay, but it apparently dies out towards the southwest so that the St. Clair river and the south end of lake Huron were only slightly affected. If the Mattawa-Ottawa region was uplifted before the ice-dam broke it would follow that the surface of the lake in the region near the dam was not up to the level of the highest beaches at the time of the break, and hence that the whole lake was not lowered over 500 feet when the dam broke, as it must have been the case if that event occurred before all the uplifts. In

*Am. Jour. Sci. vol. XLIX, April 1895, footnote on page 258.

†The Inland Educator, Terre Houte, Ind., vol. 2, No. 4, p. 222, May 1896.

the latter case the surface of the lake must have fallen from its place at present lake level at Port Huron, Mich., in Saginaw bay, and at Two Rivers, Wis., to a level 500 feet lower or to within 80 feet of present sea level. Then there had to intervene time enough for about 500 feet of uplifts in the Mattawa-Ottawa region before the Nipissing beach could have begun to be formed. We cannot say positively that this was or was not the course of events. It is a possible alternative. But it seems much more likely, and it apparently agrees better with the Niagara gorge, to suppose that the major part of the Algonquin uplifts occurred during the life of lake Algonquin and hence before the breaking away of the ice dam in the Ottawa valley. In this case when the break came the level of the lake at North Bay was not very much above the pass and the fall to the pass and to the level of the Nipissing beach was not great. But we do not know whether the change was directly to the Nipissing beach, the uplifts ceasing then altogether, or whether there may not have been some slight uplifting at North Bay after the fall to the level of the pass.

The whole subject of the Algonquin uplifts and their relations to the lake history is extremely complex. While a large number of data have been gathered which bear on the questions involved, probably many more will be needed before any decisive conclusion can be reached. But in justice to the subject and to those who have been most closely connected with its study it should be said that the data even now on hand have not yet been fully worked over. An account of submergence phenomena observed at lower levels in the Mattawa and Ottawa valleys will be given in another paper.